Mergers, pollution and environmental policy

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Abstract: We examine the impact of abatement taxes on the pollution level in a duopoly framework with *endogenous* market structure. We demonstrate that an increase in abatement taxes could trigger a regime-switch from Cournot competition to merger, as well as from merger to Cournot competition. The nature of this switch is critically dependent on the nature of merger costs. However, in either case, this may cause the pollution level to *increase*.

Key words: Mergers, pollution, abatement tax, endogenous market structure.
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1 Introduction

There has been a growing realization that environmental degradation has serious socio-economic implications for the present and future generations. This realization has sparked an explosion of interest in environmental economics, in particular the role of regulation in controlling environmental degradation. In this paper we seek to explore the interlinkages between environmental regulation and market structure.

In the analysis of environmental policy, the assumption of a competitive product market is the most common one.[1] Though there is some literature which assumes that the product market is monopolistic,[2] until recently much less attention has been given to the case of oligopoly.[3]

Most of the literature with an oligopolistic market structure, however, assumes that the market structure is exogenously given. While this is a reasonable assumption in some contexts, under some scenarios, however, it may be more reasonable to assume that the market structure is endogenous. For example, we shall focus on the case where the firms endogenously decide whether to operate competitively, or opt for merger.[4] In that case we would like to argue that policy conclusions that hold with an exogenously given market structure, need not hold when the market structure is endogenous.

In this paper we seek to examine the effect of environmental policy on the incentive for *mergers* in dirty industries, and the consequent effect on pollution.

Mergers, of course, are an important business phenomenon.[5] Some level

[1] See, among others, Baumol and Oates (1998).

[2] See, for example, Buchanan (1969).

[3] See, among others, Carraro and Soubeyran (1996).

[4] Another scenario could be where entry is free and firms endogenously decide whether to enter the market or not.

[5] As Martin (1993) argues, policy makers have great faith in the efficiency enhancing effect of mergers. He quotes the 1984 US Department of Justice Merger Guidelines and

of activity in the merger market is always visible, even in less developed countries.[6] Moreover, mergers are often active in large businesses involving dirty products.[7] Given this fact, we feel that studying the interaction between mergers and environmental policy is of some importance. In our model the endogeneity of the market structure arises since whether a merger takes place or not is decided by the firms themselves.

We develop a theory of mergers based on synergy. Mergers are often said to be motivated by synergy whereby one partner is efficient in some aspects, whereas the other partner is efficient in other aspects.[8] Thus, in case of merger, the partner firms can access each others strengths, leading to a synergistic reduction in costs.[9]

Thus merger has two advantages over Cournot competition. First, there is the gain due to synergy, and second, by merging, the firms can avoid the dissipation of rents. However, merger involves some fixed costs as well. This can be attributed to two main reasons, cultural and organizational differences between the two firms and the fact that a merger may be contested. Depending on the relative magnitudes of these effects there can be either joint venture formation, or Cournot competition.

The nature of merger costs have important implications for our analysis. Suppose that merger costs are primarily due to cultural differences.

other sources in this context. Of course, whether mergers are actually beneficial from a social point of view is a widely debated issue.

[6]See, among others, Jacquemin (1990) and Roy (1997).

[7]For a list of firms involved in mergers in the Indian market in 2000-2001, we refer the readers to http://www/indiainfoline.com/stok/meam/mg19.html. Even a causal perusal of this list suggests that many of these mergers took place among firms in dirty industries.

[8]In the Indian context, for example, the merger between Reliance Petroleum and Reliance Industries is said to be fuelled by such synergies (see Srinivasan (2002)).

[9]Theoretically, allowing for such synergies allows one to get around the problems discussed in Salant et al. (1983). An alternative approach, based on capital agglomeration in the merged firm, was developed by Perry and Porter (1985).

The analytical implication is that in that case merger costs are likely to be independent of the level of environmental policy.[10] Next consider the case where merger costs arise because its contested. In case of mergers (or acquisitions) there are often important organizational changes post-merger. In fact, in certain cases the incumbent management of the firms may be removed. Thus, in the face of such threats, mergers are likely to be contested by the management (as well as other stake-holders interested in the continuation of independent Cournot firms). Contesting mergers, however, are costly.[11] In case the merger still goes through, these costs have to be borne by the merged firms. Note that in such a scenario merger costs are likely to be increasing in the Cournot profits (and thus on environmental policy). This is because in case Cournot profits are large, the managers and other stake-holders have a greater interest in preventing a merger and are likely to contest the merger much more vigorously.

We examine a dirty industry where production leads to pollution, the level of pollution being monotonically related to the level of output. The government uses several policy measures (e.g. imposing emission taxes etc.) so as to control the level of pollution. All these policy measures create an abatement cost for the firms. Clearly the stricter the governmental policy, the higher is the abatement cost.

We then briefly summarize our main results.

We first consider the case where the merger costs arise because of the merger being contested. In this case we find that an increase in abatement costs may lead to a regime switch from Cournot competition to merger.

[10] In a different context Kabiraj et al. (2001) use cultural differences to explain joint venture breakdown.

[11] These involve various components, contacting the share-holders, informing them regarding the potential problems in case a merger goes through, researching the other firm, arranging for board-meetings etc.

Moreover, in case the synergistic effect is large, this may cause the level of pollution to *increase*.

We then consider the case where merger costs arise because of cultural and organizational differences between the two firms. In this case we demonstrate that an increase in abatement costs may lead to a regime switch from merger to Cournot competition. Moreover, in case the synergistic effect is small, this may cause the level of pollution to *increase*.

Thus we demonstrate that an increase in abatement costs may lead to regime switches in the concerned market. Interestingly, the exact nature of the regime switch depends on the nature of merger costs. The regime switch result is of interest by itself since, in a study of the first 200 Fortune 500 companies, Zanetti and Abate (1993), argue that in industrialized countries big corporations often respond to environmental policy through organizational innovations.

Moreover, we find that there exist parameter values such that an increase in abatement taxes may cause the pollution level to *increase*. We find that this is true irrespective of the nature of merger costs.

The above finding corroborates our contention that when the market structure is endogenous, environmental policy may have some non-obvious effects on the level of pollution. Moreover, there is some evidence that even very high level of abatement taxes may fail to reduce pollution levels sufficiently.[12] Our analysis suggests that one possible explanation could be that such high level of abatement taxes causes a regime-switch to a more polluting market structure.

We then briefly relate our work in this paper to the existing literature.

[12]For example, evidence presented by the European Commission regarding the European carbon tax, based on research carried out by several research institutes, suggest that even a very high carbon tax achieves only half of the required reduction target. See, Carraro and Siniscalco (1994).

First consider the case where the market structure is exogenously given. In an n-firm Cournot framework, Katsoulacos and Xepapadeas (1996), show that an increase in emission tax decreases the output level and increases abatement expenses. Moreover, the optimal tax is less than marginal damages. Conrad and Wang (1993) solves for the effects of the emission tax on the output of an oligopolistic industry. In contrast to the above models, Carraro and Soubeyran (1996), Ulph (1996a) and Ulph (1996b), among others, examine the impact of emission taxes when the firms are heterogenous.

Next consider the case where the market structure is endogenous. In a homogeneous product industry with free entry, Katsoulacos and Xepapadeas (1995) show that the optimal emission tax may exceed marginal environmental damages. Clearly, the framework adopted by Katsoulacos and Xepapadeas (1995) is very different from that in our paper.

The rest of the paper is organized as follows. In the next section we describe the basic framework. Section 3 contains the main results. Finally, section 4 concludes.

2 The Model

The market comprises two firms, firm 1 and firm 2, producing a homogenous product. The market demand function is given by

$$q = a - p, \tag{1}$$

where a (> 0) is the parameter of market size.

For the i-th firm its production cost, $C_i(q_i)$, as well as its abatement cost, $A_i(q_i)$, are linear in the level of output. Thus $C_i(q_i) = cq_i$ and $A_i(q_i) = Aq_i$, where A is the initial abatement cost parameter. Note that the abatement cost is a linear version of the abatement cost function used by Barrett (1994).

Thus the total cost of the i-th firm is given by

$$cq_i + Aq_i,\ i = 1, 2. \tag{2}$$

We consider a simple two stage game.

Stage 1. The firms sequentially decide whether to opt for Cournot competition, or merger. There is merger if and only if both the forms opt for it.

Stage 2. In case there is Cournot competition, the firms simultaneously decide on their level of output. In case of a merger, the merged firm becomes a monopoly that maximizes its own profits.

We solve for the subgame perfect Nash equilibrium of this game.

Merger. Under a merger the production cost of the merged firm is given by $c'q$, where $c' < c$. The assumption $c' < c$ reflects the fact that merger leads to a synergy in the cost structure. Thus if c' is small compared to c, then we say that the synergistic effect is large. If c' is close to c, then we say that the synergistic effect is small.

Moreover, merger formation also involves a fixed cost $F(A)$. This can arise because of two main reasons, either cultural and organizational differences between the two firms and/or the fact that a merger may be contested. In case of mergers, the existing managers are often replaced by new ones. Thus the managers are likely to oppose a merger in case such replacement is likely. Since this is done using the resources of the firms themselves, contesting a merger involves some costs for the parent firms.

As we shall see later, the nature of merger costs play a crucial role in the analysis.

We assume that the profits under merger (net of merger costs $F(A)$) is equally divided among the two firms. Let $M_i(q)$ denote the profit level of

the i-th firm under merger. Then

$$M_i(q) = \frac{1}{2}[a - c'q - Aq - F(A)]. \tag{3}$$

Letting $\hat{q}$ denote the equilibrium level of aggregate output

$$\hat{q} = \frac{a - c' - A}{2}. \tag{4}$$

Thus the equilibrium level of profit of both the firms

$$\widehat{M} = \frac{(a - c' - A)^2}{8} - \frac{F(A)}{2}. \tag{5}$$

Cournot Competition. We then examine the outcome under Cournot competition. Letting $P_i(q_1, q_2)$ denote the profit function of the i-th firm under Cournot competition

$$P_i(q_1, q_2) = (a - q_1 - q_2)q_i - cq_i - Aq_i, \;\; i = 1, 2. \tag{6}$$

Thus the reaction functions are given by

$$\frac{\partial P_i(q_1, q_2)}{\partial q_i} = (a - q_i - q_j) - q_i - c - A = 0, \;\; i = 1, 2. \tag{7}$$

Let $\overline{q}_i$ denote the equilibrium output level of the i-th firm. It is standard to show that in equilibrium $\overline{q}_1 = \overline{q}_2$. Hence

$$\overline{q}_1 = \overline{q}_2 = \overline{q} = \frac{a - c - A}{3}. \tag{8}$$

The equilibrium profit level of each Cournot firm

$$\overline{P} = \frac{1}{9}(a - c - A)^2. \tag{9}$$

From equations (4) and (8) we have the following

Observation. *Consider a scenario where the market structure is exogenously given. Under both merger and Cournot competition, the equilibrium level of aggregate output, and hence pollution, are decreasing in A.*

3 The Analysis

In this section we examine the effect of an increase in the abatement cost parameter from A to A' on market structure, as well as the level of pollution.

Depending on the nature of merger costs there are two cases to consider.

3.1 Merger costs arising because the merger is contested

In this sub-section we focus on the extreme case where merger costs arise because the merger is contested. For expositional simplicity, in this sub-section we assume that there are no organizational, or cultural costs of a merger.

As argued earlier, in such a situation mergers are likely to be more bitterly contested greater the Cournot profit levels. This is because when the Cournot profits are high, then the existing managers have a greater stake in the mergers and are likely to contest the merger vigorously. Thus in this case merger costs are increasing in the level of Cournot profits.

To begin with we examine whether under the existing level of abatement cost A, there is going to be merger or Cournot competition. Suppose that A is not too large to begin with i.e.

$$a > c + A > c' + A, \tag{10}$$

so that Cournot competition is feasible (merger is also feasible provided $F(A)$ is not too large). We then assume that merger costs are reasonably large in the sense that

$$\frac{F(A)}{2} > \frac{(a - c' - A)^2}{8} - \frac{(a - c - A)^2}{9}. \tag{11}$$

Thus initially there will be Cournot competition.

We consider the effect of an increase in abatement costs to A' ($> A$).

For simplicity we assume that

$$c + A' > a > c' + A'. \tag{12}$$

Note that in this case Cournot competition is not feasible (since $c + A' > a$). Thus in this case we assume that the fixed cost of merger is zero, i.e. $F(A') = 0$, since neither of the firms want to contest the merger. Thus merger will take place (since $a > c' + A'$) and the profit level of both the firms under merger is

$$\frac{(a - c' - A')^2}{8}, \tag{13}$$

and the aggregate output level is

$$\frac{(a - c' - A')}{2}. \tag{14}$$

Thus in this case an increase in A causes a regime switch from Cournot competition to merger.

Summarizing the above discussion we obtain our first proposition.

Proposition 1. *Suppose that (i)* $a > c + A > c' + A$, *(ii)* $\frac{F(A)}{2} > \frac{(a-c'-A)^2}{8} - \frac{(a-c-A)^2}{9}$, *(iii)* $c + A' > a > c' + A'$ *and (iv)* $F(A') = 0$. *Then an increase in the abatement cost from* A *to* A' *causes a regime switch from Cournot competition to mergers.*

We then compare the level of pollution under merger and Cournot competition. Since the level of pollution is monotonically related to the level of output, it is sufficient to compare the aggregate output level under merger and Cournot competition.

From equations (8) and (14), the aggregate output (and hence the pollution level) increases after the shift in abatement cost to A' if and only if

$$c' < a - A' - \frac{4(a - c - A)}{3}. \tag{15}$$

Summarizing the above discussion we obtain our next proposition.

Proposition 2. *The pollution level when there is merger and the abatement cost is A', exceeds that under Cournot competition when the abatement cost is A, if and only if $c' < a - A' - \frac{4(a-c-A)}{3}$.*

There are three effects at work here. As A increases to A', pollution is likely to decrease since the industry moves from duopoly to monopoly, and since, under any given market structure, the abatement cost increases. However, the pollution level is likely to increase because of the synergistic effect. The condition that $c' < a - A' - \frac{4(a-c-A)}{3}$ essentially ensures that the synergistic effect is large enough, i.e. c' is small enough, for this to happen.

From Propositions 1 and 2 we obtain Corollary 1, the main result of this sub-section.

Corollary 1. *Suppose that (i) $a > c+A > c'+A$, (ii) $\frac{F(A)}{2} > \frac{(a-c'-A)^2}{8} - \frac{(a-c-A)^2}{9}$, (iii) $c + A' > a > c' + A'$, (iv) $F(A') = 0$ and (v) $c' < a - A' - \frac{4(a-c-A)}{3}$. Then an increase in the abatement cost from A to A' causes a regime switch from Cournot competition to mergers. Moreover, there is an increase in the level of pollution.*

The following example shows that the above corollary is not vacuous.

Example 1. Let $a = 10,\ c = 4,\ c' = 0,\ A = 4,\ A' = 7$ and $F(A) = \frac{75}{9}$. Note that in this case all the hypotheses of Corollary 1 are satisfied.

3.2 Merger costs arising out of cultural and organizational differences

In this sub-section we focus on the case where the merger costs arise because of cultural and organizational differences. For expositional ease in this sub-section we assume that mergers are never contested at all.

In this scenario the merger cost is clearly independent of the abatement cost. Thus $F(A) = F$, $\forall A$.

Let us consider the incentive for merger formation $I(A)$, where $I(A)$ denotes the difference in profit level between individual firms under merger and Cournot competition. Thus

$$I(A) = \frac{(a - c' - A)^2}{8} - \frac{F}{2} - \frac{(a - c - A)^2}{9}. \tag{16}$$

Straightforward calculations demonstrate that $\frac{dI}{dA} < 0$.[13] Thus for any $A' > A$, there exists F such that $I(A') < 0 < I(A)$. Hence in this case there will be merger when the abatement cost is A, and there is Cournot competition when the abatement cost is A'.

Summarizing the above discussion we obtain our next proposition.

Proposition 3. *Suppose $F(A) = F$, $\forall A$. For any $A' > A$, there exists F such that there is merger when the abatement cost is A, and there is Cournot competition when the abatement cost is A'.*

Note that in this case a regime switch from Cournot competition to merger is triggered by a *decrease* in the abatement tax. This result is the exact opposite to that of Proposition 1. Thus Propositions 1 and 3 together show that the nature of the regime switch in our model is critically dependent on the nature of merger costs.

We then examine if an increase in A can cause the level of pollution to increase or not.

Combining Propositions 2 and 3, we obtain our final result.

[13] Note that

$$\frac{dI(A)}{da} = \frac{-(a - c - A) - 9(c - c')}{36}.$$

Since Cournot competition is feasible, we have that $a - c - A > 0$. Moreover, because of synergy, $c > c'$. Hence the claim follows.

Corollary 2. *Suppose that* $I(A') < 0 < I(A)$ *and* $c' > a - A' - \frac{4(a-c-A)}{3}$. *Then an increase in abatement costs from* A *to* A' *causes a regime switch from merger to Cournot competition. Moreover, this causes an increase in the level of pollution.*

The intuition is straightforward. With an increase in abatement costs there is a regime switch from mergers to Cournot competition. Given that the synergistic effect is small, the level of output, and hence pollution increases as a result.

The following example shows that the above corollary is not vacuous.

Example 2. Let $a = 10,\ c = 4,\ c' = 3,\ A = 4,\ A' = 6$. Note that we can always find appropriate values of F such that all the hypotheses of Corollary 2 are satisfied.

4 Conclusion

In this paper we examine the effect of environmental policy in a duopoly structure where the firms endogenously decide whether to opt for Cournot competition, or merger. We demonstrate that an increase in abatement costs may lead to regime switches from Cournot competition to merger, or the other way round. Interestingly, the exact nature of the regime switch depends on the nature of merger costs. In case the merger costs arise because mergers are contested, we find that an increase in abatement costs causes a regime switch from Cournot competition to mergers. Whereas if merger costs are due to cultural differences, an increase in abatement costs may lead to a regime switch from merger to Cournot competition.

Moreover, we find that there exist parameter configurations such that an increase in abatement taxes may cause the pollution level to increase.

We find that this is true irrespective of the nature of merger costs. The above finding corroborates our contention that when the market structure is endogenous, environmental policy may have some non-obvious effects on the level of pollution.

From a policy point of view our analysis suggests that, while analyzing the implications of environmental policy, the linkage between environmental policy and market structure needs to be addressed seriously.

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